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DISPOSAL OF HIGH COBALT-60 SCAVENGED WASTES

AUTHOR

W. A. Haney

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DISPOSAL OF HIGH COBALT-60 SCAVENGED WASTES

By

W. A. Haney

Process Demonstration & Analysis
Chemical Effluents Technology Operation
CHEMICAL RESEARCH & DEVELOPMENT OPERATION

March 4, 1957

HANFORD ATOMIC PRODUCTS OPERATION
RICHLAND, WASHINGTON

Operated for the Atomic Energy Commission by the
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FOREWORD AND RECOMMENDATION

This document relates to the disposal to ground of a specific radioactive waste solution on a production test or "use test" basis. The test will serve a dual purpose. In the first place, it will allow the disposal, at a good ratio of savings to cost, of at least a part if not all of a large volume of material which otherwise would require the emergency type of disposal (on a specific retention basis) or tank storage. Secondly and of similar importance, it should provide an unusual opportunity for study of the dispersion of liquids in the groundwater, a phenomenon ill-defined at the present time and of considerable interest in Hanford waste disposal practice.

As the document explains, this proposed full scale test is not without risk but a careful analysis of the technical aspects, as we now understand them, and a consideration of the radiological hazards control requirements do not, in our opinion, contraindicate the feasibility and safety of the procedure.

The activation of this use test is recommended.

DW Pearce

Manager, Chemical Effluents Technology
CHEMICAL RESEARCH & DEVELOPMENT OPERATION

D.W. Pearce/dnb

DISPOSAL OF HIGH COBALT-60 SCAVENGED WASTES

INTRODUCTION

Early in 1956 it was discovered that TBP scavenged wastes contained significant concentrations of Co^{60}, and that the complexed form of the radioisotope was resulting in little or no removal by soil adsorption mechanisms. $Ru\text{-}Rh^{106}$ was known to be present in significant concentrations, yet did not limit disposal since it has a half-life of less than three years (1.0 y.), and a relatively high MPC. As a result, the recommended cribbable limit for Co^{60} concentration in scavenged wastes was set at less than 4×10^{-5} μc/cc, the maximum permissible concentration in drinking water for non-occupational consumption. Unsuccessful attempts to develop a process for scavenging Co^{60} to obtain a concentration in the supernate below the recommended cribbable limit have resulted in trench disposal on a specific retention basis of practically all scavenged wastes produced since June, 1956.

Disposal by specific retention has been permitted in the past and is presently recommended as an emergency measure to be resorted to only when lack of tank storage space is a threat to continued operation of separation processes. Occasional use of trenches is justified for disposal of small volumes of liquid which, if mixed with large volumes of conventional wastes, may render the whole batch unsuitable for crib disposal. The objections to this mode of disposal are the lack of knowledge relating to the movement of unadsorbed radioisotopes placed in soils, its relatively large consumption of land, and the potential presented for excessive personnel radiation exposures and serious incidents. Research in progress and review of past experience may show eventually that disposal via specific retention may be used as a standard mode of disposal for selected wastes.

Recent laboratory tests employing representative samples from approximately 18,000,000 gallons of "in-farm" stored TBP wastes indicate that these wastes can be decontaminated to a Co^{60} concentration below 4×10^{-4} μc/cc, (MPC for occupational exposure), but not as low as the current cribbable limit.

PURPOSE

The object of this report is to define a use test for the disposal of a large fraction of in-farm scavenged wastes. The disposal plan as outlined should advance the knowledge of waste dispersion in groundwater of the region, and permit discharge of significant volumes of waste to existing cribs, thereby achieving sizeable economies over alternate methods. Knowledge of composition and amount of radioactive isotopes entering the cribs, particularly Co^{60}, will permit tracing the passage of waste components through existing and planned wells in the downstream direction from the disposal point. Stratification or vertical sinking of the waste in groundwater may be correlated to ground horizons and waste characteristics.

SUMMARY

Existing cribs in 216-BC should be used for disposal of in-farm scavenged wastes under the following conditions:

1. All waste to be sampled and analyzed in the manner presently established, including Co^{60} determination.

2. Adequate soil adsorption for Cs^{137} and Sr^{90} to be demonstrated by laboratory test prior to disposal as in the past.

3. Co^{60} concentration not to exceed 4×10^{-4} $\mu c/cc$.

4. Cribs to be used in the order established in this report. No more than 1,000,000 gallons per month should be disposed.

5. Use of a crib to be discontinued when Cs^{137} appears in the groundwater at 0.1 MPC. Crib disposal also to be terminated should unforeseen developments show that a hazardous or otherwise undesirable condition may be resulting.

6. Four new monitoring wells and deepening of an existing well will be required within 6 months of the start of disposal.

The disposal as outlined is not intended to establish a precedent for future disposal practice. The proposed plan of discharge is designed to permit a large scale investigation of the behavior of wastes in the groundwater and economically dispose of a significant volume of waste. It is hoped that such a test will clarify some of the uncertainty regarding the ultimate fate of waste discharged to groundwater. Such information may permit, in the future, some relaxation of the present disposal criteria.

DISCUSSION

A. Disposal Plan and Requirements

One of the two objectives of the disposal is to discharge the waste safely and economically to the ground so that recovered underground storage space will be made available to receive high activity wastes produced by the prime separation plants. The other objective is to collect data that may be useful in hydrological studies relating to stratification and dilution or dispersion of wastes in groundwater and groundwater movement.

The 216-BC cribsite, originally intended for scavenged wastes, is available for this disposal. Since it lies far south of cribsites in which Co^{60} has penetrated to groundwater, it is unlikely that movement of this material in groundwater will interfere with the use test outlined. Direction of groundwater movement in this general region is known with some assurance, permitting the strategic placing of test wells. The relatively great depth to groundwater should permit large volumes of waste to be discharged prior to Cs^{137} breakthrough, thereby increasing the likelihood of Co^{60} entering the groundwater in concentrations easily measured. To date, the six BC cribs have received about 8,500,000 gallons of scavenged waste. Co^{60} concentrations in wastes discharged to the BC-2, 3, 5 and 6 cribs have been below 4×10^{-4} $\mu c/cc$. Co^{60} concentrations in wastes discharged to the BC-1 and BC-4 cribs are unknown, but were probably in this range. Present evidence, based on results of well probings and groundwater sampling, indicates that none of the wastes discharged to the BC cribs has entered the regional groundwater table.

Based on experience with scavenged waste disposals at the 216-BY cribsite, it is estimated that each of the BC cribs can receive a total of 4,000,000 gallons of waste before breakthrough of Cs^{137} into the regional groundwater table will occur. Allowing for waste already discharged in the BC site, approximately 10,000,000 additional gallons of waste may be sent to the BC-2, 3, 5 and 6 cribs. Use of the BC-1 and BC-4 cribs at this time is not recommended since information on Co^{60} concentration in waste sent to these cribs is not available.

The suggested disposal plan is based on an expected in-farm scavenging rate of 700,000 gallons of supernate per month, or one batch (~ 500,000 gallons) every three weeks. Wastes should be added to the BC-2 3, and 6 cribs until each has received approximately the volume of waste that has been discharged to the BC-5 crib (2.25 million gallons). Subsequent disposal of each successive batch to a different crib should insure equilibrium being established in the downward movement of waste through the subsoil prior to further addition of waste to the crib.

Cribline samples should be obtained and analyzed as has been the practice in past scavenged waste disposals. Soil column testing of these samples to determine Cs and Sr adsorption characteristics for each batch should also be continued. From these results reasonable predictions may be made of the total volume which may be disposed to the crib(s) prior to breakthrough.

Anticipated use of the gamma spectrometer well probe to det[illegible]s of penetration of radioisotopes in the soil will assist in predict[illegible]time when contamination will enter the regional groundwater table. [illegible] will be continued until an undesirable condition arises (e.g. Cs^{137} br[illegible]h) that requires removal of the crib(s) from service. The appearance [illegible] in groundwater up to the MPC (4×10^{-4} $\mu c/cc$) will not restrict the use of the cribs for this test disposal.

Four new monitoring wells and deepening of an existing well will be required to monitor the movement of contamination after it enters the regional groundwater. Three of the four new wells will be drilled through the groundwater until the blue clay of the Ringold formation is intersected. The fourth well will be drilled to basalt, as will be the deepened well. Two of these wells will be drilled about one half mile to the southeast of the cribsite. The third well will be drilled about 1-1/2 mile from the cribsite, in the same direction, and the fourth well will be drilled at a distance of about two miles south of the cribsite. Well 299-E-13-5 will be deepened an additional 300 feet. The wells are situated in the general path of anticipated groundwater moving from the cribsite under predicted groundwater gradients.

Some additional provisions heretofore not incorporated in monitoring wells will be needed to improve the validity of the data obtained from sampling and pumping tests and to permit more extensive tests to be performed. Well-screen will be used on the three wells drilled closest to the disposal site. The use of well-screen should improve the reliability of in-well tests such as groundwater direction and rate measurements, permeability of strata measurements, and give greater assurance of representative sampling. The deepening of the one specified well and drilling the fourth well to basalt will permit sampling traverses of the entire depth of groundwater. These studies are to identify stratification of the waste entering the groundwater as a consequence of density differences or varying permeabilities in the several soil horizons.

The wells, in addition to the specific tests relating to this planned disposal, will supplement exploratory and monitoring wells presently in use. It is anticipated that the wells will be sponsored by the Chemical Processing Department. Wells should be available within six months after the start of disposal. Continuation of disposals to the 216-BC cribsite must be dependent upon getting these wells drilled within the specified period of time. The three shallower wells should be given priority. The first well drilled should be the one nearest the cribsite. Exact coordinates for the wells will be established by Chemical Effluents Technology.

B. Present Status of Co^{60} in Groundwater

Co^{60} was detected in well water samples obtained near the 216-BY cribsite early in 1956. The highest concentration detected was 1.2×10^{-2} μc/cc. Recent groundwater samples indicate the continued presence of Co^{60} at this site; the maximum concentration detected now being 4.5×10^{-4} μc/cc. The farthest well now showing detectable Co^{60} is approximately 1000 feet southeast of the 216-BY cribsite.

C. Consequences of Disposal

It is realized that limited knowledge exists concerning the fate of radioactive materials placed in the groundwater beneath the Separation Areas Virtually all groundwater will ultimately reach the Columbia River carrying with it the undecayed radioisotopes not adsorbed on soil particles. Co^{60} present in the wastes is known to be complexed and not adsorbed, hence adsorption can not be relied upon to reduce the concentration. The half-life of Co^{60}, 5.2 years, is long enough that decay during travel to the Columbia River may effect only limited reduction in concentration. Other isotopes, principally Ru^{106}, are also present in appreciable quantities in groundwater, hence their contribution to the fraction of maximum permissible concentration at the point of use must be considered. Complete mixing in the river may not be realized for significant distances when the material to be diluted is added at the shoreline or at the bottom of the river.

These considerations and the possibility that chemically toxic material may be present in such waste streams suggest that some risk may be faced in the disposal of the subject wastes to cribs.

Mitigating factors are introduced by the disposal plan as outlined and inductive reasoning supports the conclusion that the risk is one which can be taken. Restricting Co^{60} disposed in these cribs to the maximum permissible drinking water concentration results in a relatively small total quantity of Co^{60}.

involved, some 15 curies. If this quantity were introduced to the river steadily in 5 minutes and mixing could be realized, 0.1 MPC for Co^{60} would not be exceeded. Mechanisms by which this rate of addition could be realized or even approached as a consequence of the planned disposal cannot be visualized, since the disposal will be accomplished in no fewer than 10 months. Although it is not known that accumulation of Co^{60} by river plants and organisms will not occur, the fact that this is not a long term continuing disposal reduces the magnitude of the risk from this consideration

Inert chemicals of concern in scavenged wastes are nitrate ion in concentrations of 100,000 to 200,000 ppm. and ferrocyanide ion in concentration estimated to be much less than 5000 ppm. Available data indicate that very significant dilution factors for nitrate ion in groundwater are achieved at distances of several miles from the disposal site, and even more significant reduction for the ferrocyanide is expected due to interaction with heavy elements in the soil.

It is unlikely that drinking water wells on the project will become contaminated as a result of this disposal. Two wells, five miles and seven miles northeast of the cribsite are routinely monitored for radioactivity, and are in a direction 90° from the expected direction of groundwater movement. Other drinking water wells are also routinely monitored and are more remotely located from the expected area of groundwater contamination. The appearance of significant quantities of radioactive or chemically toxic materials in wells should be detected in time to permit alternate provision for domestic water.

CONCLUSION

The use test as described should result in the acquiring of valuable data relating to movement of radioactive wastes in groundwater and permit the safe disposal of a significant volume of wastes presently held in tanks.